



2011/07/27 合原ゼミ報告

RC方形波発振器で実現する電子ホタルと その同期パタンの観察

JST, FIRST, 合原最先端数理モデルプロジェクト

川上 博, 木本圭子



話の流れ

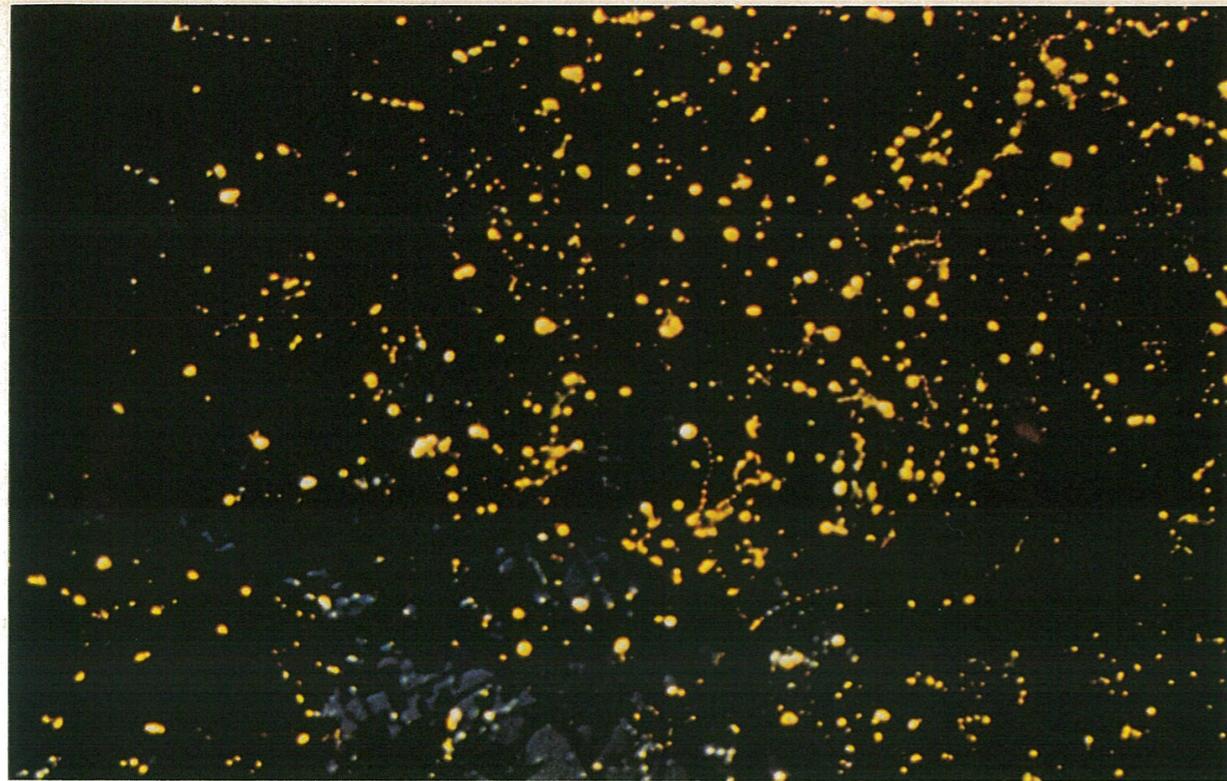
1. ことの起こり：電子ホタルの同期：実演
2. 電子ホタル：回路と同期の説明
3. 2個以上のホタルでの実験
4. むすび：今後の計画



ことの起こり：電子ホタルの同期：実演



Synchronous Fireflies, J. Buck and E. Buck, Sci. Am. Vol.234, No.5, 1976



SYNCHRONOUS DISPLAY of male fireflies in a "firefly tree" in Southeast Asia is recorded in a time-exposure photograph made by

Ivan Polunin of the University of Singapore. Synchronizing fireflies, mostly of the genus *Pteroptyx*, are found from India to New Guinea.

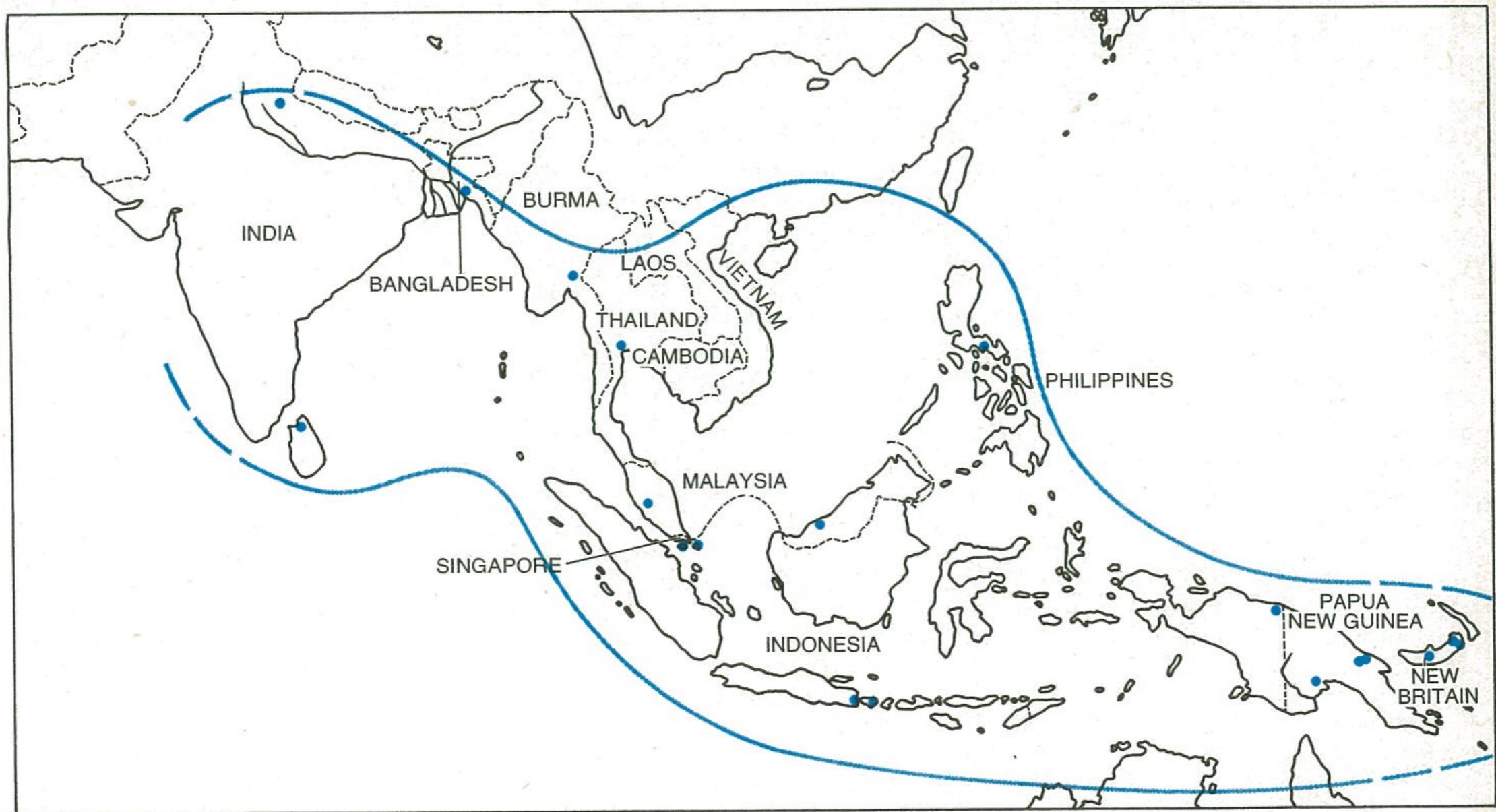


RANDOM FLIGHT of *Pteroptyx* males, taken from firefly trees in Thailand by the authors and released in a darkened Bangkok hotel

room, left the streaks visible in this time-exposure photograph. After the insects landed their rhythmic flashes soon became synchronized.



Synchronous Fireflies, J. Buck and E. Buck, Sci. Am. Vol.234, No.5, 1976



DISTRIBUTION of synchronous fireflies in Asia and the western Pacific is indicated schematically on this map. Colored dots indicate locales where synchronous displays have been observed. The westernmost area, in India, is on the Ganges east of New Delhi; the east-

ernmost is on the island of New Britain, a part of Papua New Guinea. The absence of reports from other points within the perimeter (*color*) tentatively defining the range of *Pteroptyx* species does not necessarily preclude the presence of these or other synchronous firefly species.

6



電子ホタルの同期：実演



1980年代後半～2000年：吉川研一先生
塩水Osc., PetBottle Osc. etc

1994年日経サイエンス2月号：S.H.ストロガッツ et al.

1995年日経サイエンス1月号：W. ガーバー et al.

1996 (H.8) 年NLP96-5：高坂，川上，上田

1998 (H.10) 年Trans. IEICE Vol. E-81-A, No. 4

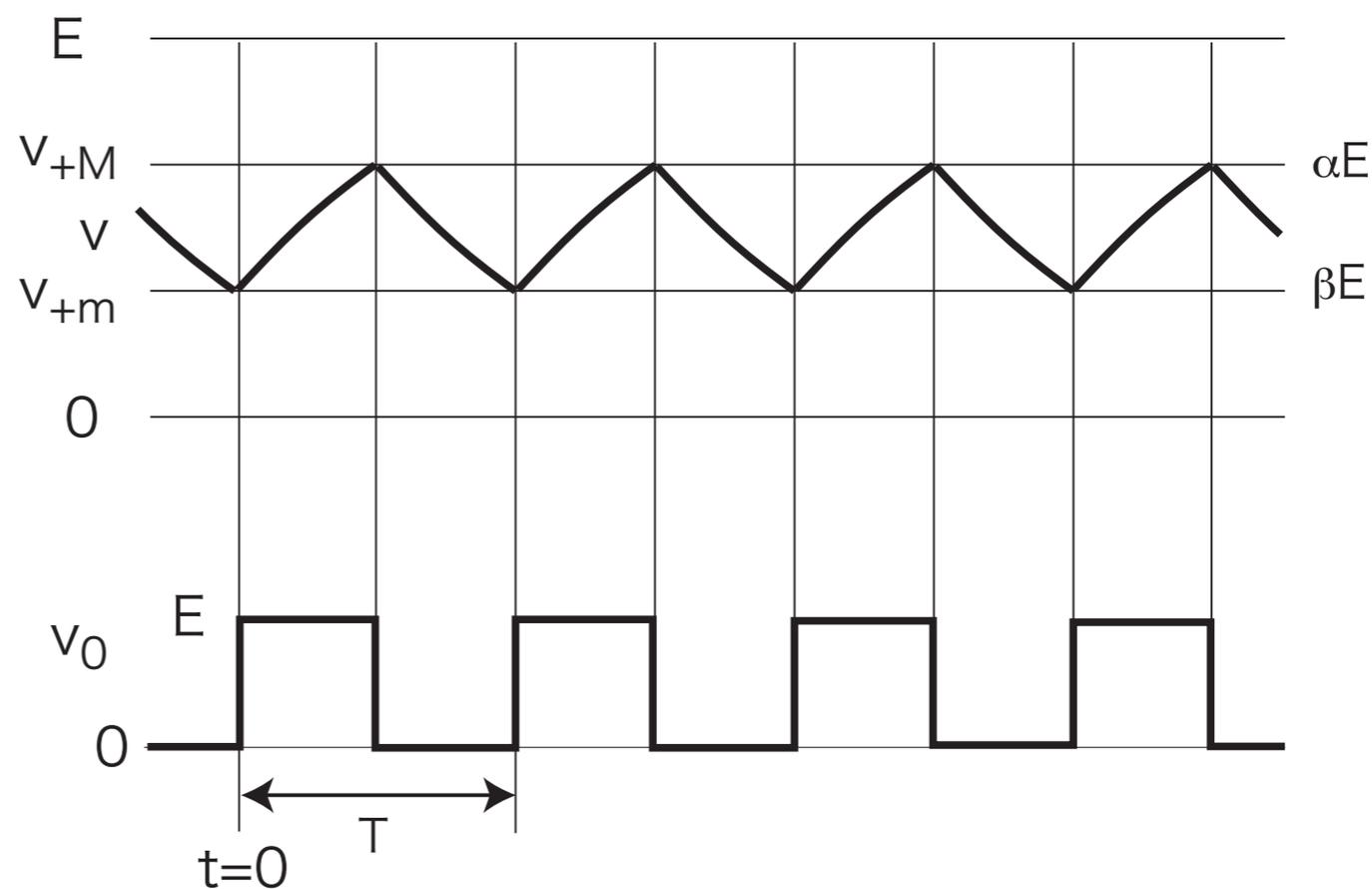
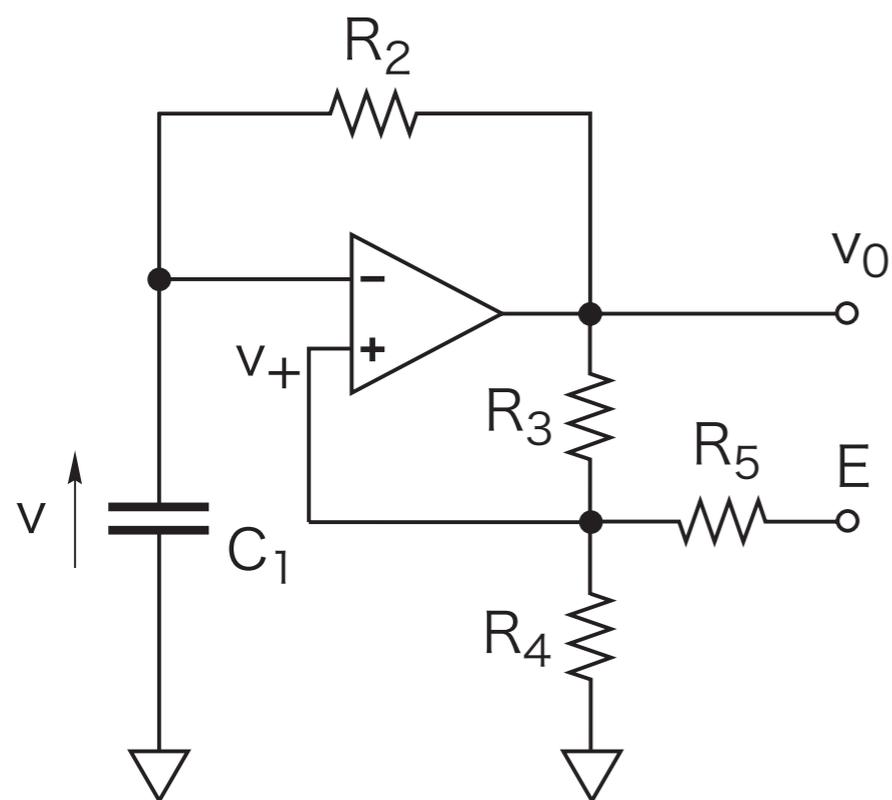


電子ホタル：回路と同期の説明

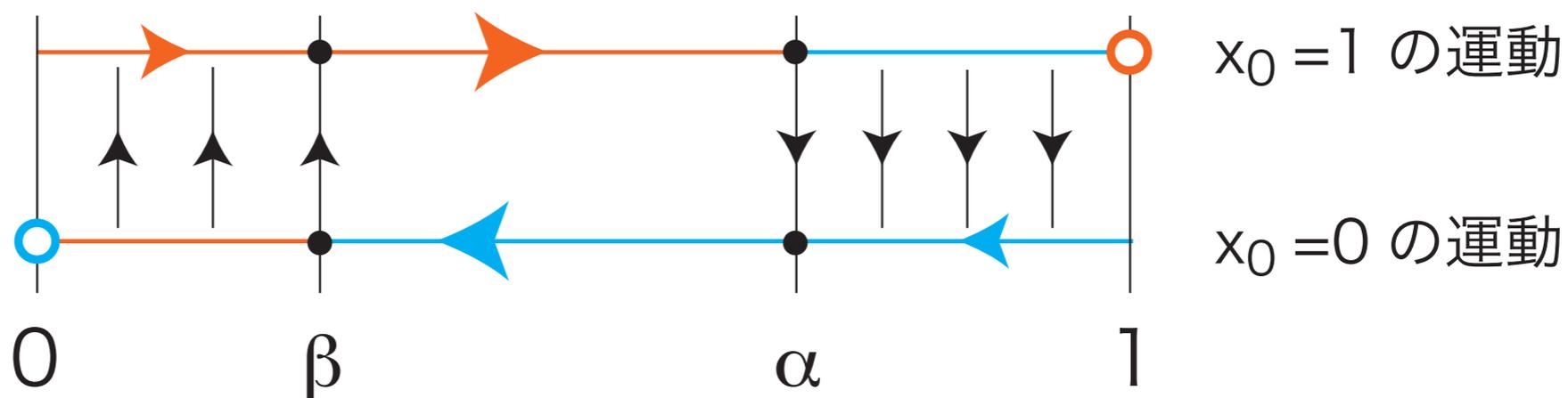
—光で制御されるRC方形波発振器—



RC方形波発振器

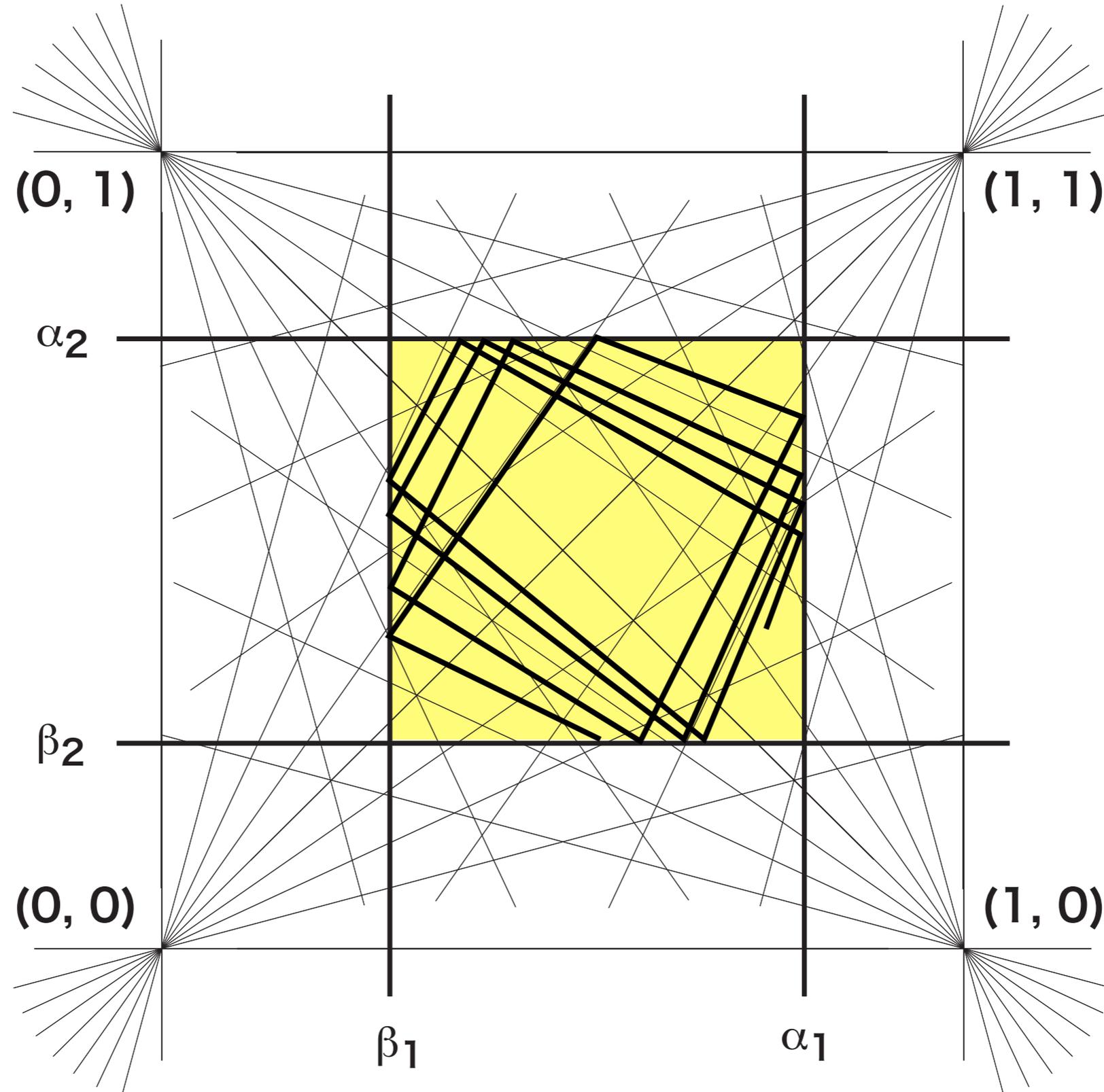


$$\dot{x} = -x \pm 1$$



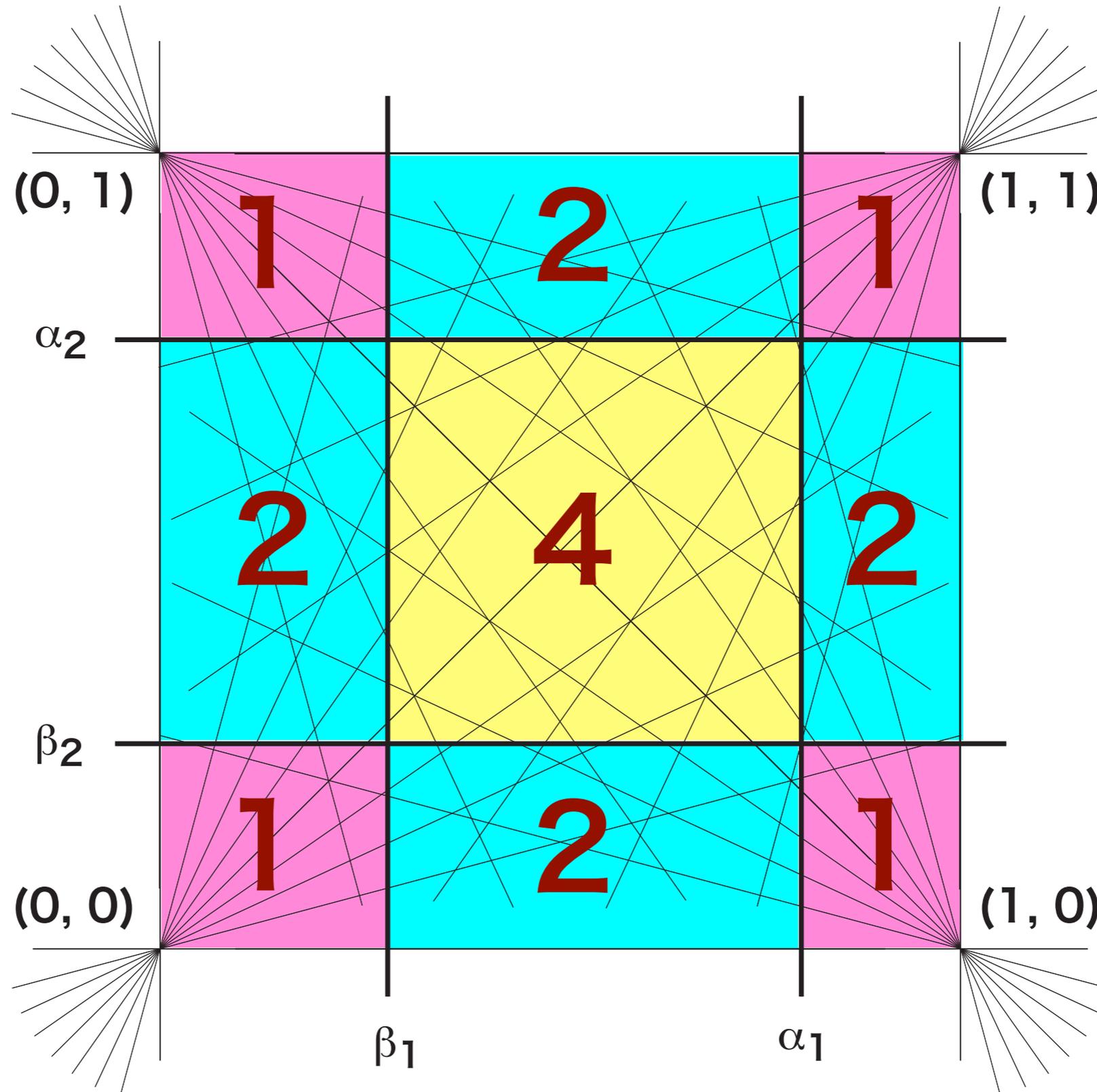


2個のRC方形波発振器：相平面図



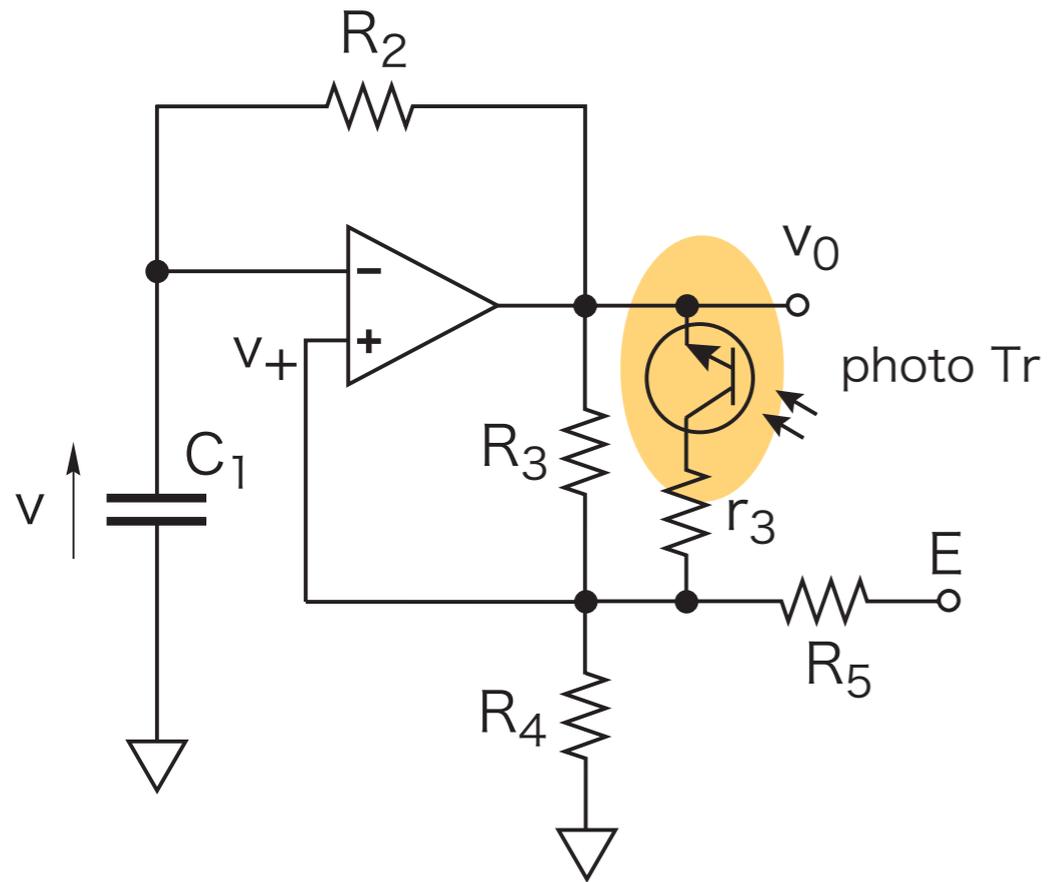


相平面図：ベクトル場の多様性

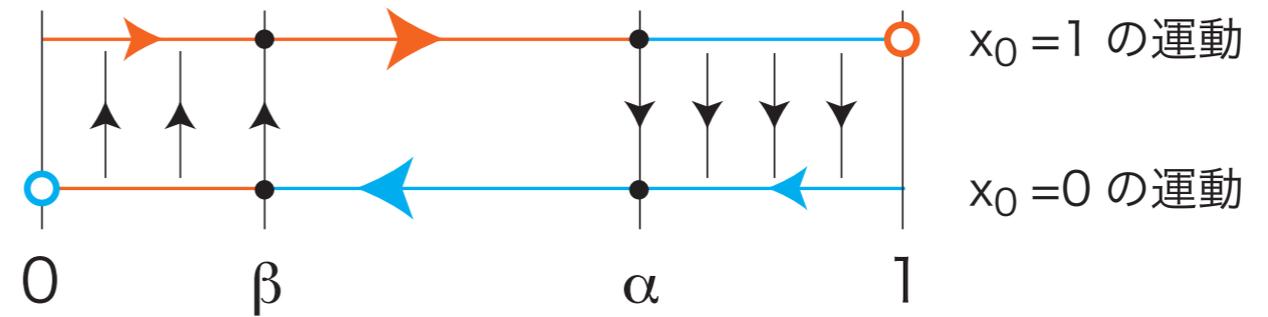




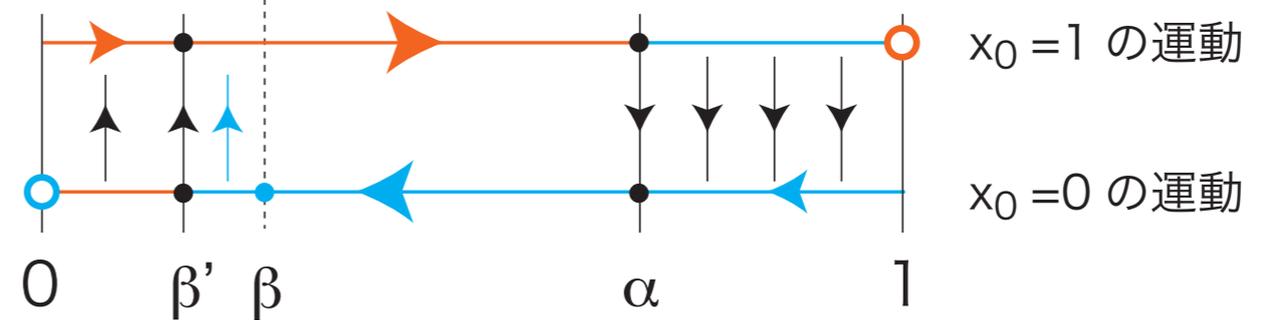
ホタル用RC方形波発振器(I)



光の照射なし

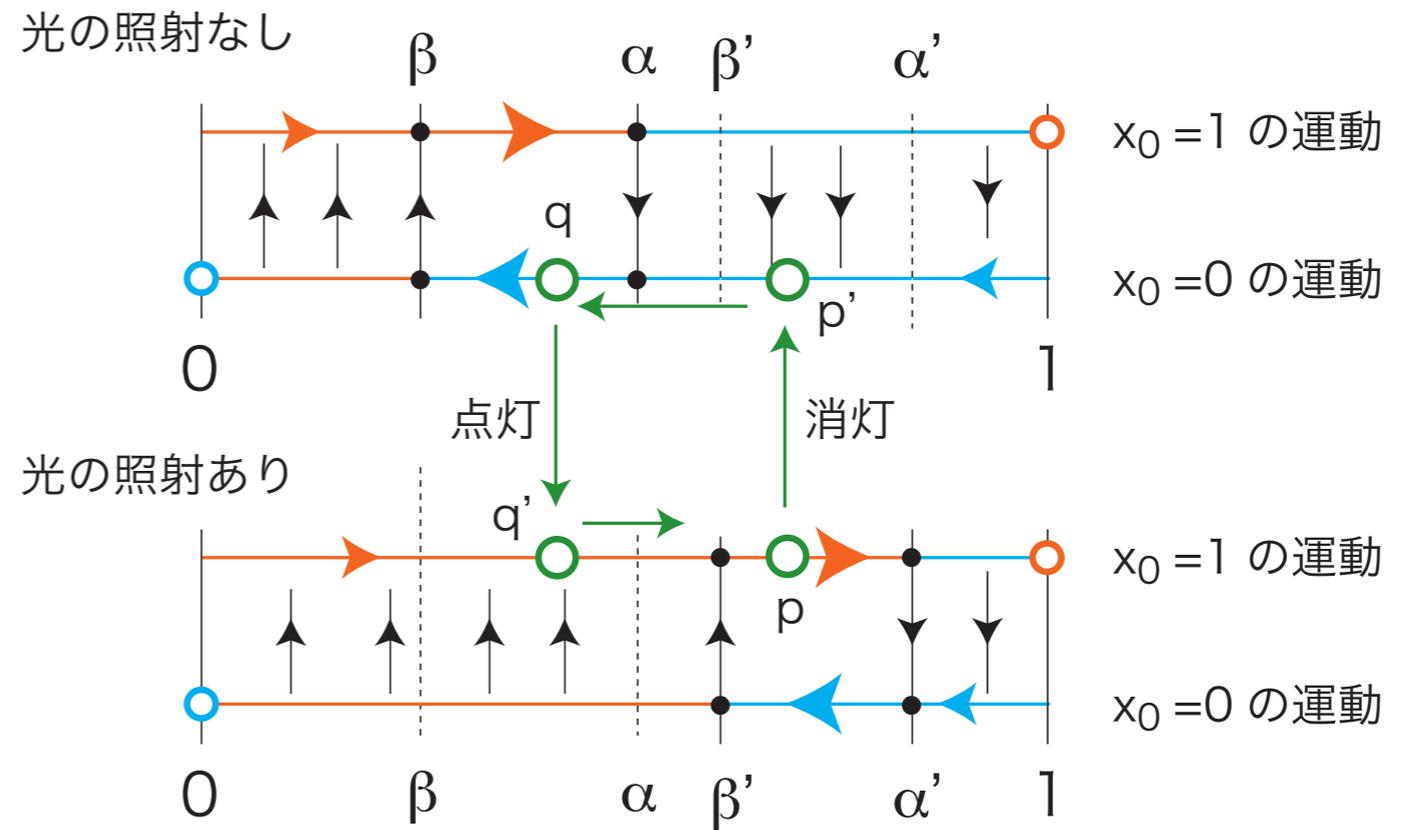
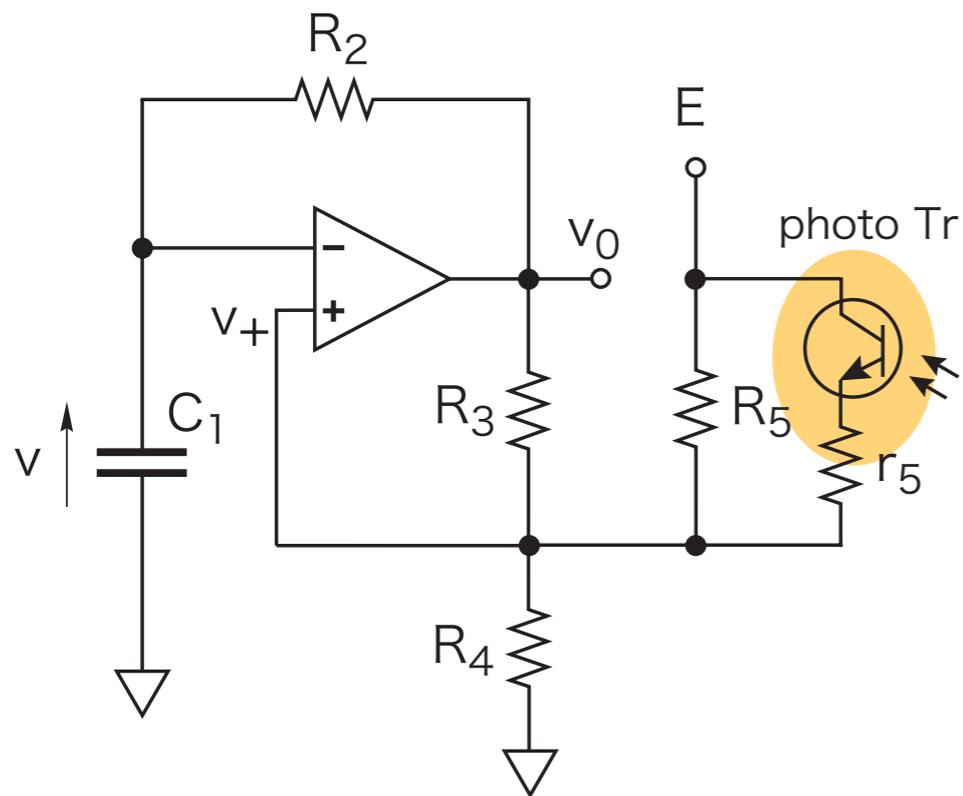


光の照射あり



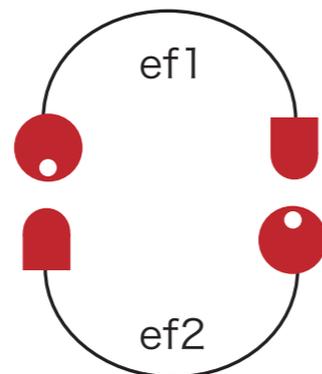
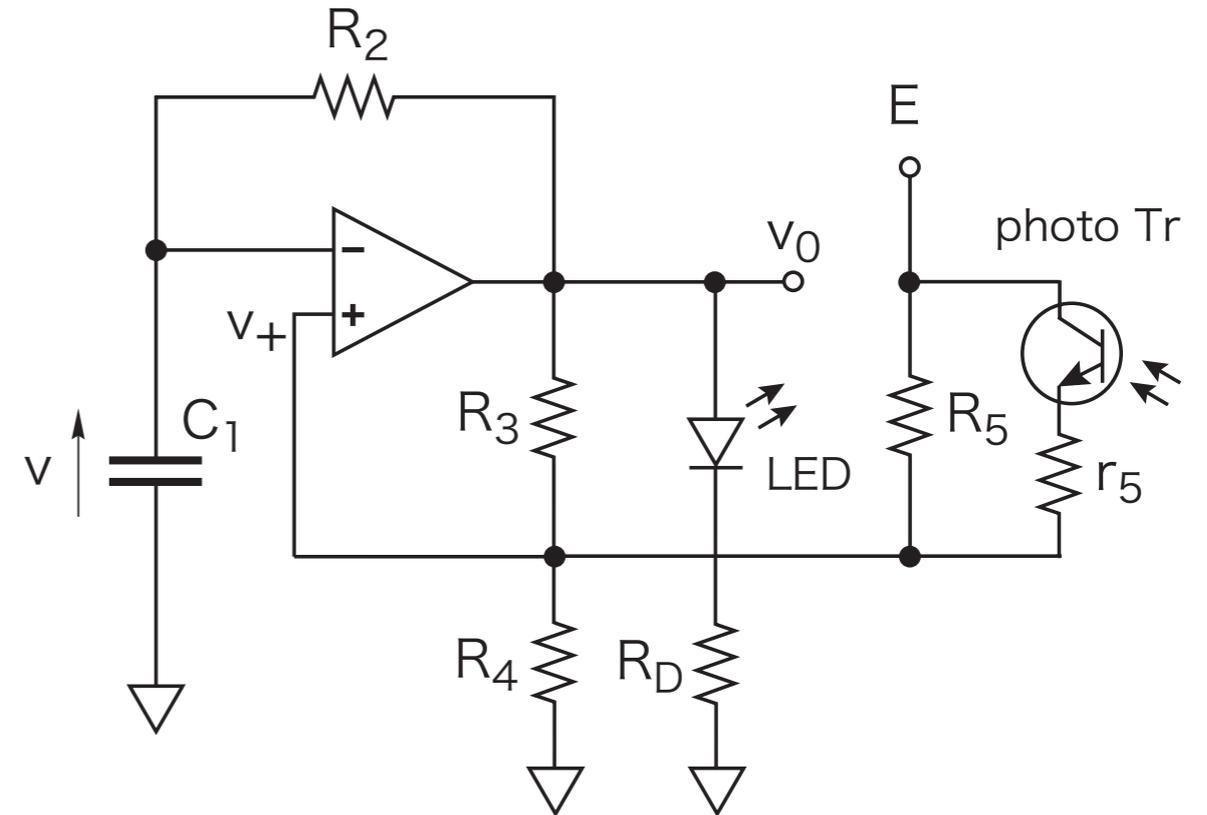
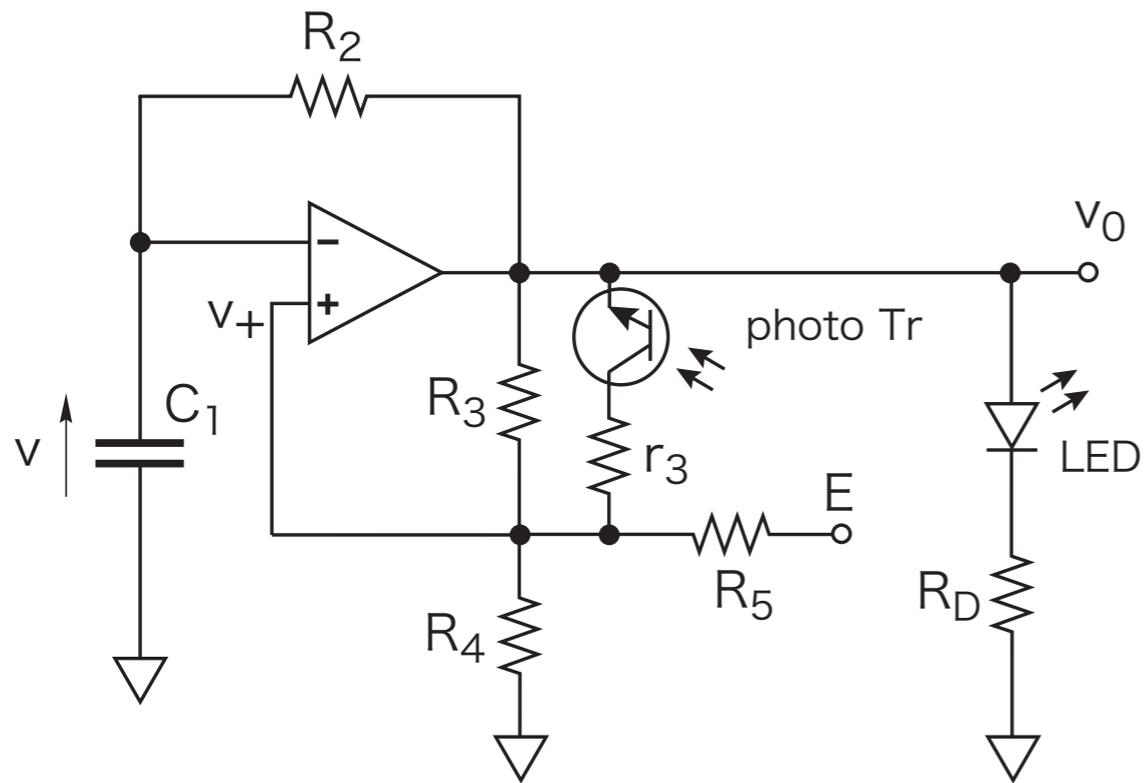
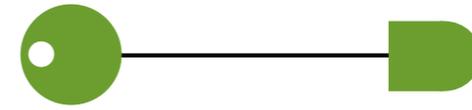


ホタル用RC方形波発振器(II)

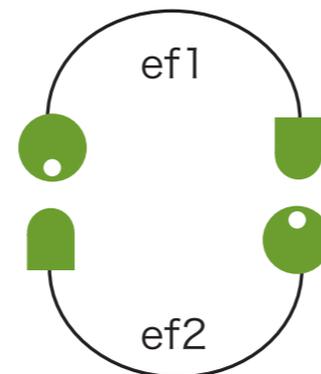




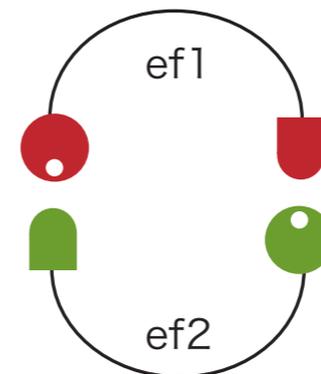
逆相同期ホタルと同相同期ホタル



(a)



(b)

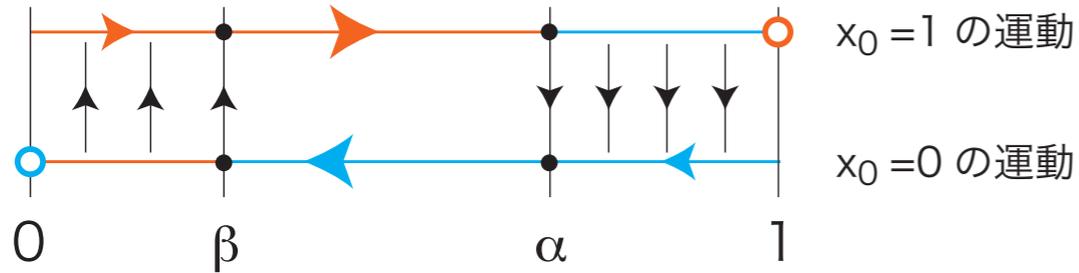


(c)

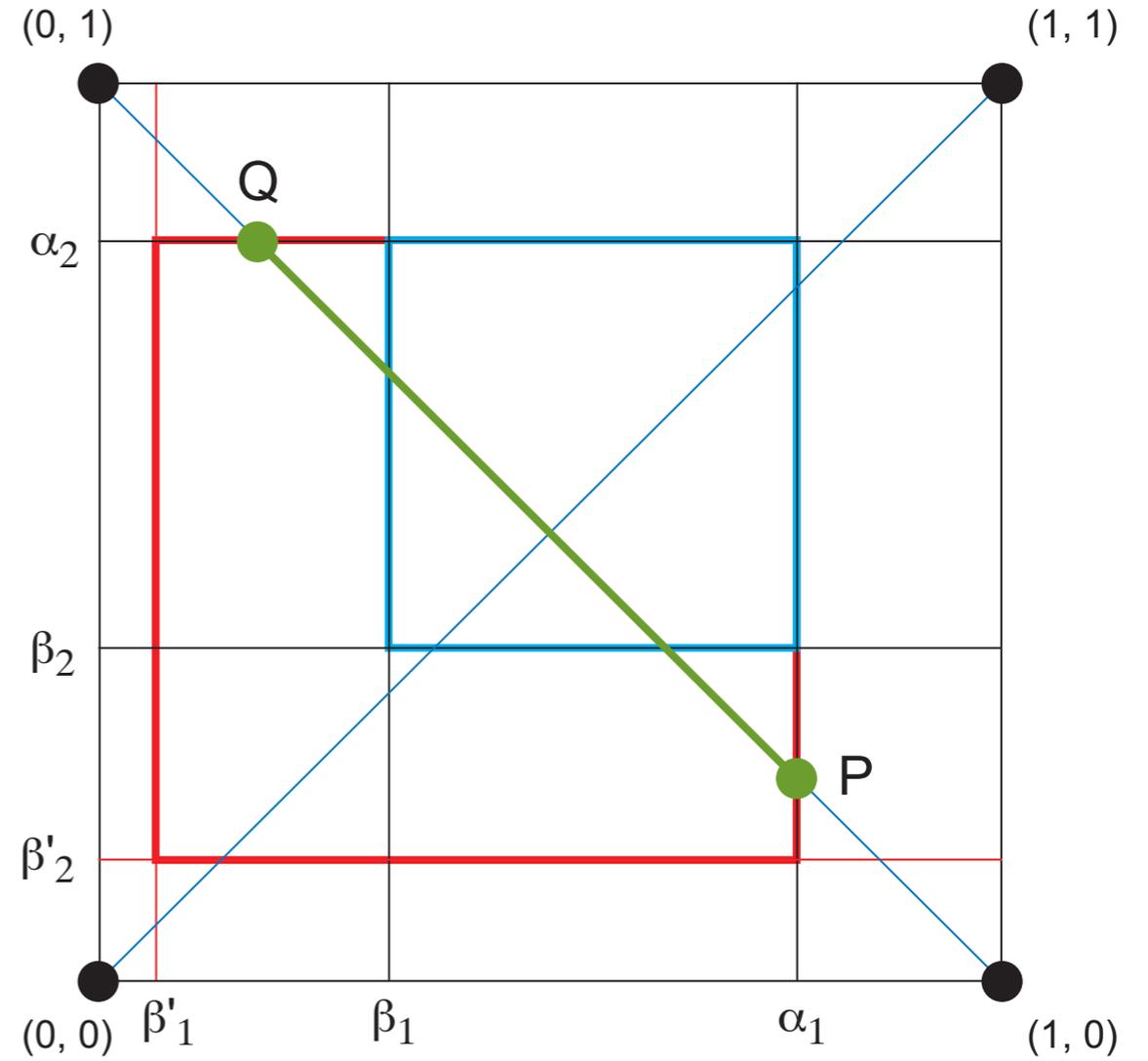
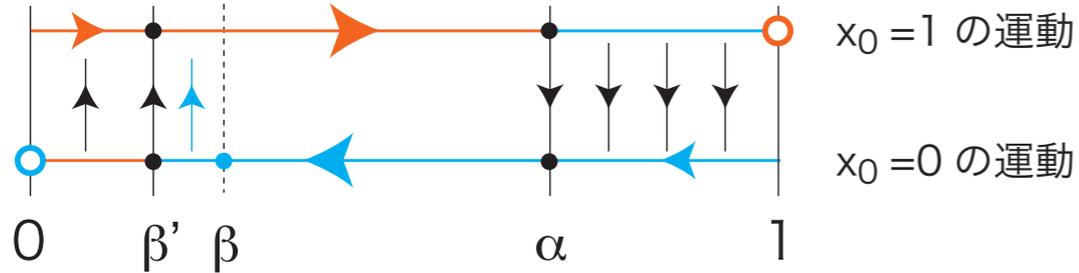


逆相同期ホタル

光の照射なし

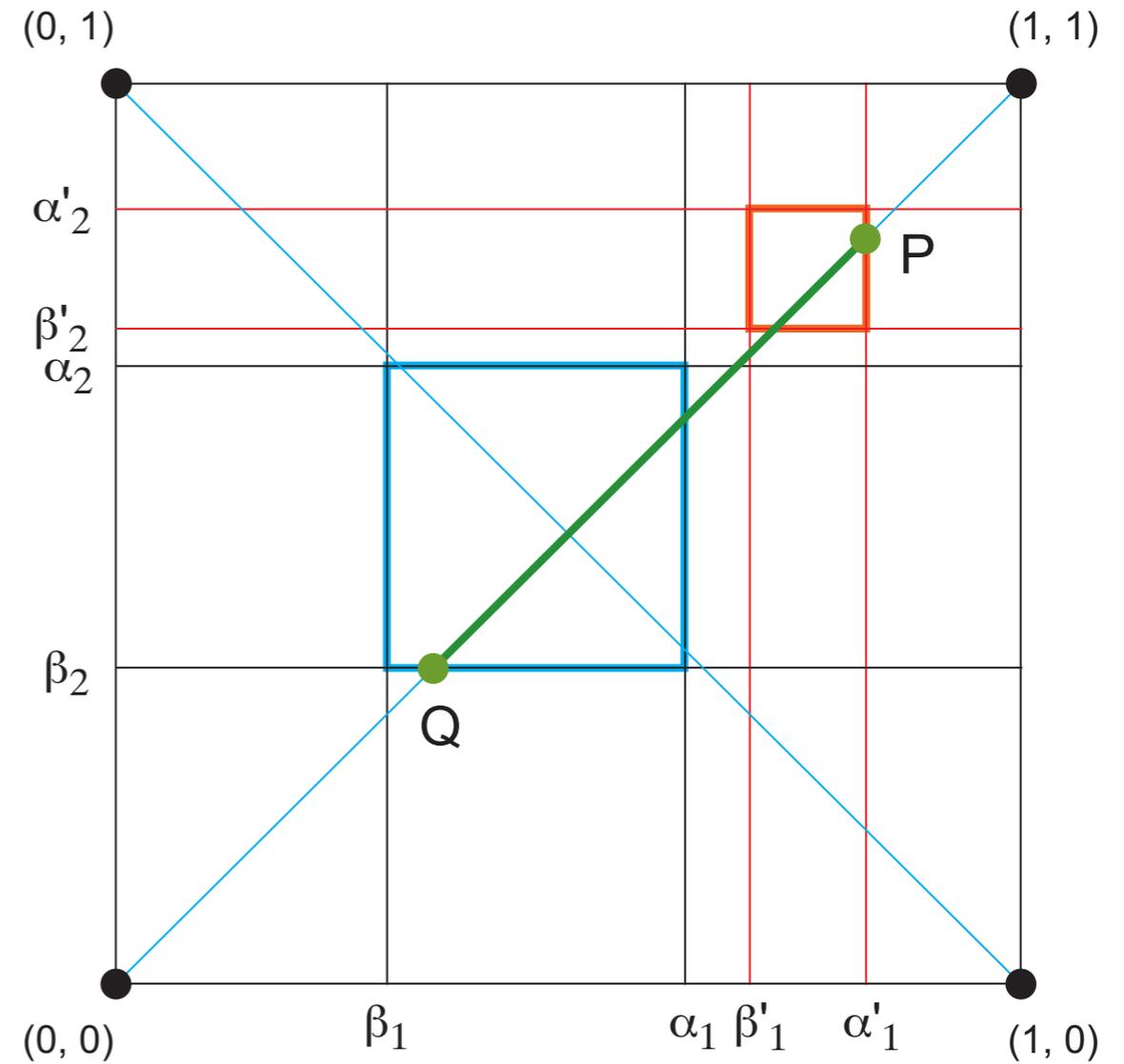
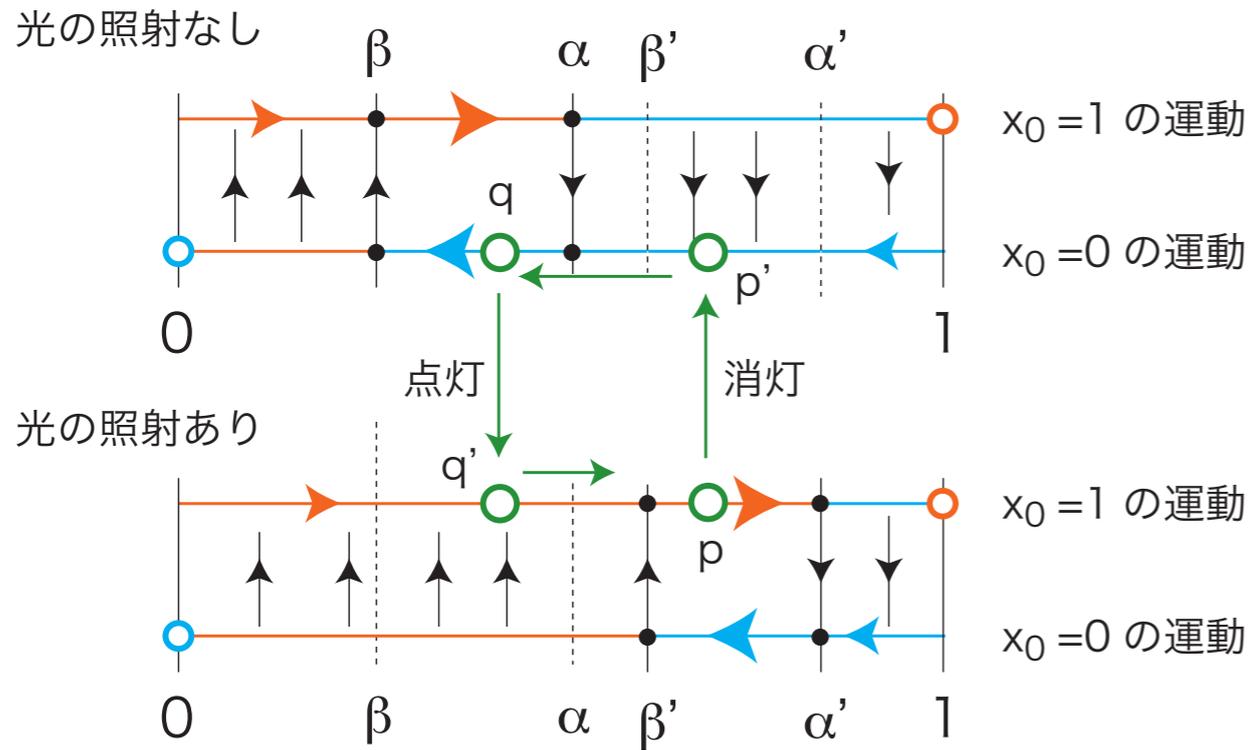


光の照射あり



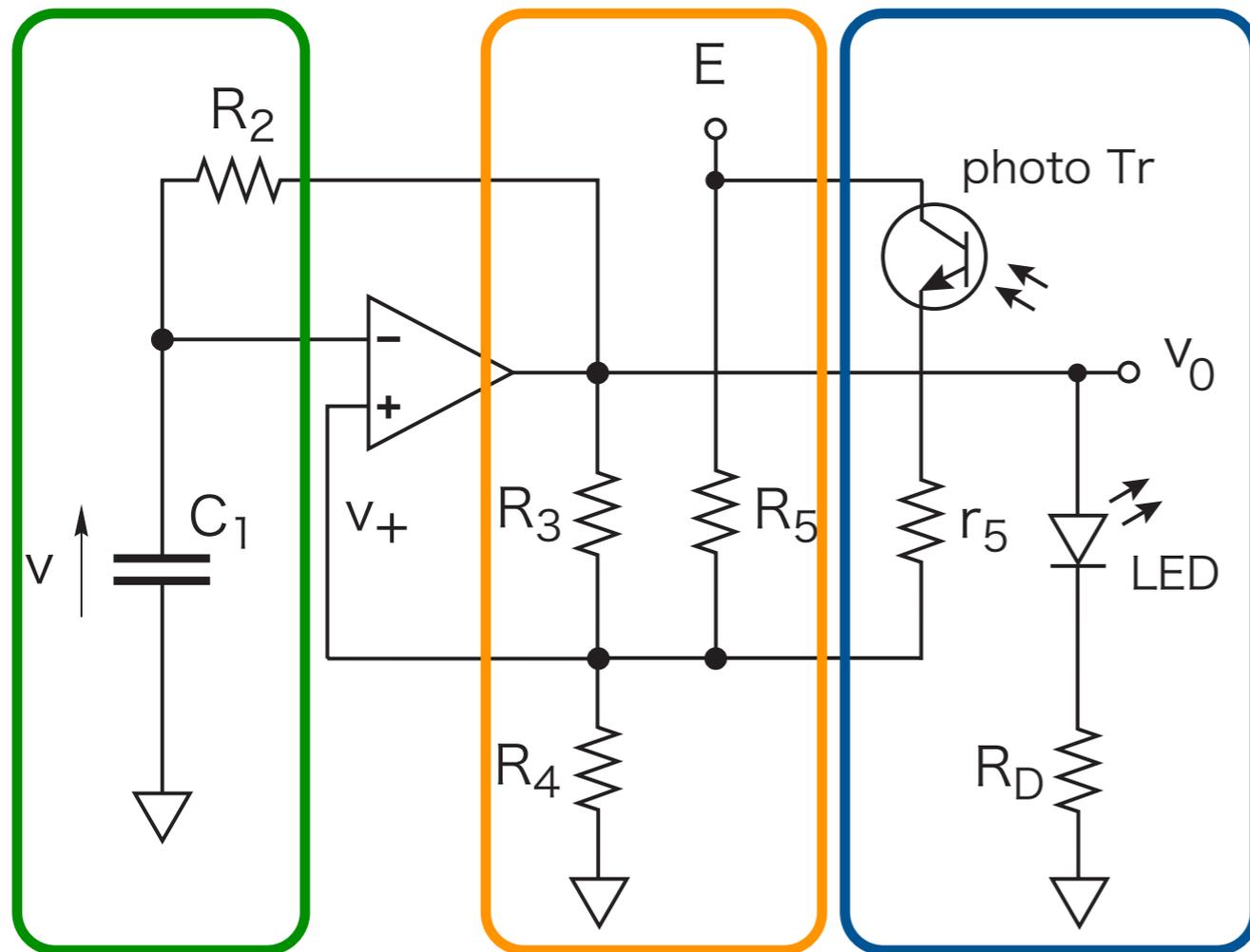


同相同期ホタル





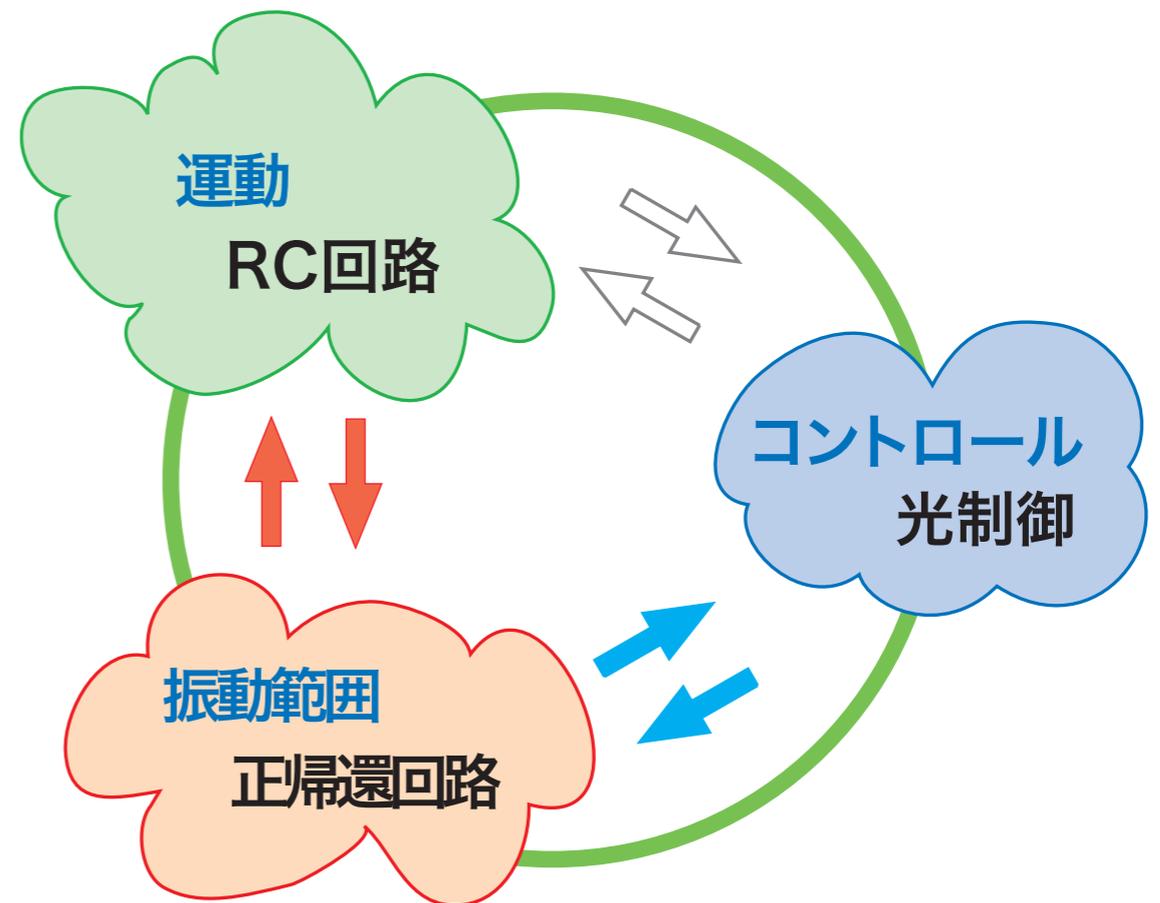
電子ホタル：回路と同期の説明



RC回路

正帰還回路

光制御部

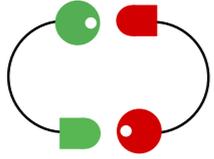




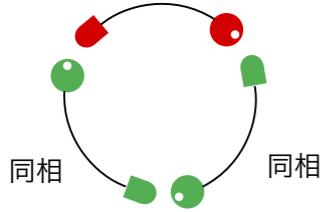
2個以上のホテルでの同期実験



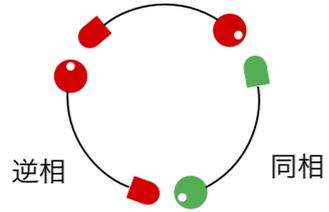
同相 逆相

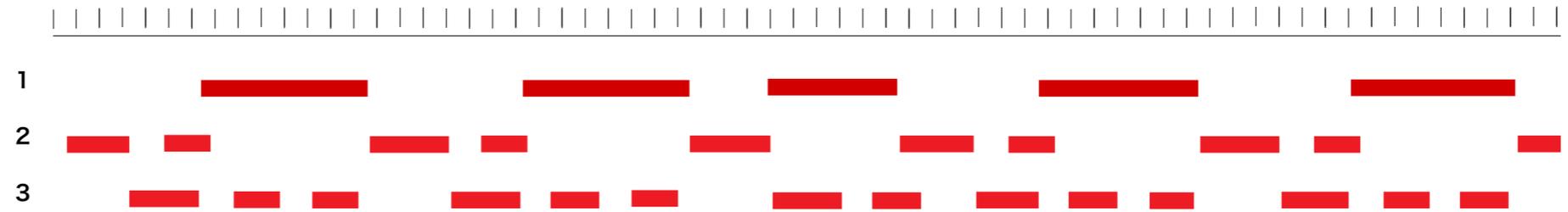
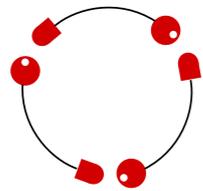
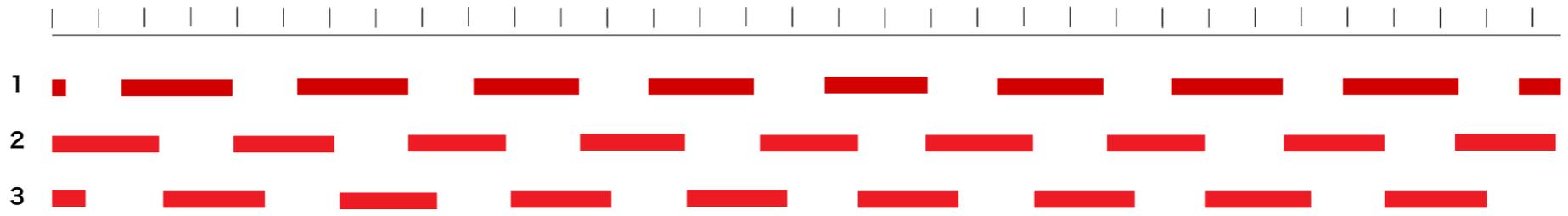
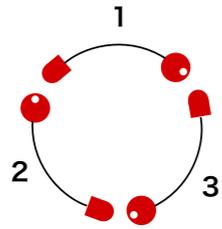


逆相



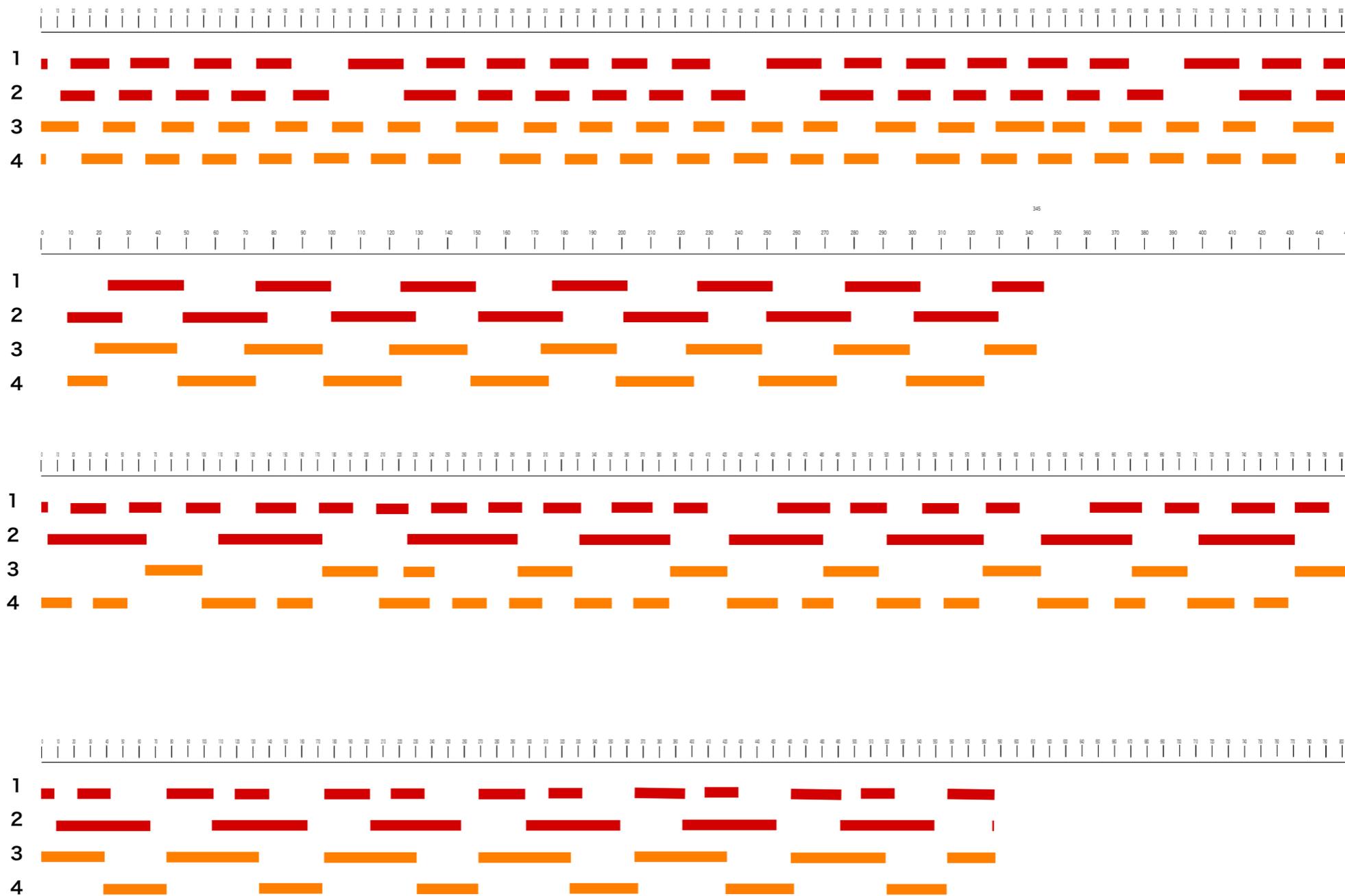
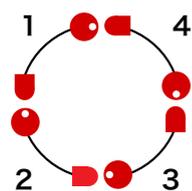
逆相







逆相 4 個





むすび：今後の計画



むすび：今後の計画

1. 光で結合した結合系の利点を活用する。
プロトタイプの回路を改良し，更に進化させる。
弛張発振器 vs 正弦波発振器
2. 光で結合した結合系の解析を行う。
力学系としての高次元系の解析をどう進めるのか
適切な応用分野はあるか
3. 電子ホタルをモチーフとしたオブジェの製作
徳島LEDアートフェスティバルへの出展



光と水の徳島

<http://tok-led-artfest.net/>



徳島LEDアートフェスティバルは、徳島が持つ水と緑の魅力に、芸術文化の力を結集し、LED技術とアートが融合した「LEDの光」を生かした新しい魅力を持つ「水都・とくしま」を創造することを目的としています。